

cat skulls (in formalin) and many anoles (in alcohol) were added to the Vertebrate Collection of The University of Connecticut (UConn) following the method presented. The effects of bouillon (mostly salt, hydrolyzed vegetable protein, corn syrup solids, sugar, and beef fat) and seasoning (mostly salt, sugar, monosodium glutamate, hydrolyzed vegetable protein, and maltodextrin) solutions on bone (mostly calcium and phosphate) may include the creation of cations that would make the solution become alkaline and could cause bone corrosion. However, for bones placed in the bouillon/seasoning solution for two weeks, we found no evidence of the solution becoming alkaline. Since 1985 and for all specimens prepared using this method, we have found no effects on the preservation of bone using the mixtures of bouillon and seasoning.

We agree with Gritis and Brunner (1990) that many factors (e.g., time in water or solution, condition and cyclic activity of the beetle colony, size of specimen, presence of salt as a main ingredient in bouillon or seasoning) may affect the success of preparing skeletons from fluid-preserved specimens. Use of bouillon or seasoning packets is a successful alternative that offers many advantages. First, it is inexpensive. Bouillon cubes, instant bouillon, or soup packages usually cost under \$2.00 at grocery stores. Second, the solutions can be prepared easily any time and stored before and after use. Lastly, this procedure produces practically no odor, and does not stain bones.

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FRANK J. DIRRIGL JR.
ROBERT E. DUBOS
and

PHILLIP E. RUSCH

Department of Ecology and Evolutionary Biology
The University of Connecticut, U-43
Storrs, Connecticut 06269-3043, USA.

Retention Of Imitation Satellite Transmitters Fiberglassed To The Carapace Of Sea Turtles

It is difficult to collect continuous data on animals that are wide-ranging, hard to capture, and spend limited time in accessible areas. Sea turtles, for example, are present at the ocean's surface for < 2 hr a day (Byles 1989; Renaud 1990; Standora et al. 1984) and the chance of unaided multiple observations on one or more of these animals is uncommon. Satellite and radio telemetry are two methods of remote sensing available to study various aspects of sea turtle biology (Byles 1988, 1989; Byles and Dodd 1989; Dizon and Balazs 1982; Keinath et al. 1989; Kemmerer et al. 1983; Kolz et al. 1980; Manzella et al. 1990; Renaud et al. 1992; Standora et al. 1984; Standora et al. 1989; Stoneburner 1982; and Timko and Kolz 1982).

Methodology for the attachment of satellite tags (platform transmitter terminals; PTTs) has improved such that PTTs may remain on sea turtles longer than 10 months. However, there are concerns that PTTs may 1) not completely detach from the animal, 2) interfere with breeding behavior, 3) increase the chance of predation on sea turtles, 4) interfere with feeding behavior, or 5) inhibit sea turtle growth. This paper reports on the retention and usefulness of tags fiberglassed to the carapace of Kemp's ridley (*Lepidochelys kempi*) sea turtles and addresses these concerns.

MATERIALS AND METHODS

Twelve sub-adult Kemp's ridley sea turtles (ca. 32 months old) from the Kemp's ridley Head Start project at the National Marine Fisheries Service (NMFS) Galveston Laboratory were fitted with imitation satellite transmitters (ISTs) (Fig. 1, Table 1). Sea turtles were held individually, indoors in partitioned raceways (2.0 X 2.0 X 0.5 m per turtle) for 16 months. They were fed Purina Trout Chow supplemented with live blue crabs (*Callinectes sapidus*) during the last month of their captivity.

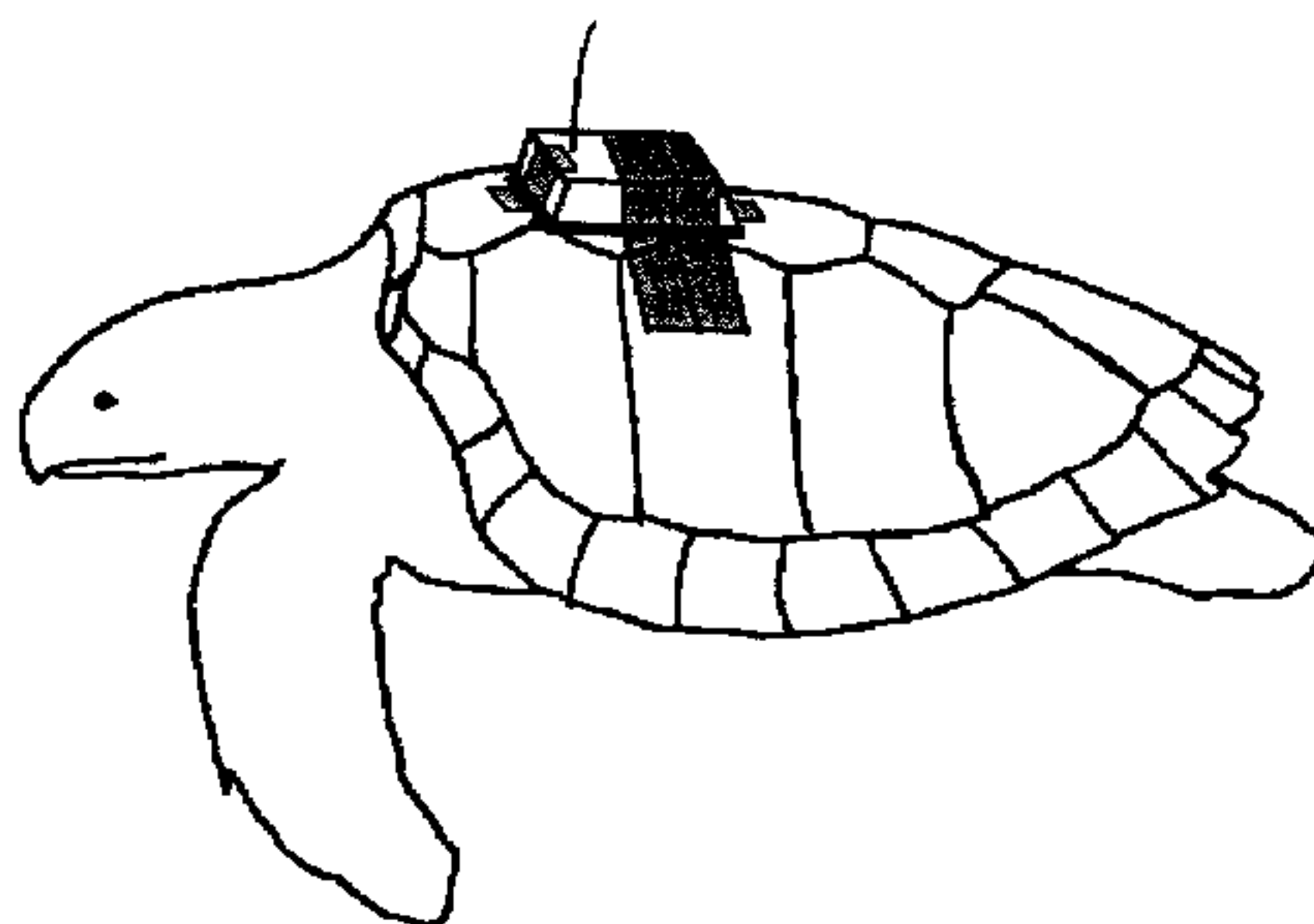


FIG. 1. Schematic of Kemp's ridley sea turtle with imitation satellite transmitter.

Tag Design and Fabrication.—ISTs, fabricated with epoxy resin, were designed after Telonics ST-3 satellite transmitters. They were scaled down in dimension (13 x 8 x 2 cm) and weight (335 g) to accommodate the small size of sea turtles available for experimentation. Scaled-down dimensions were based on the proportion of dimensions of the Telonics ST-3 satellite transmitter to straight carapace lengths (51-60 cm) and widths (48-56 cm) of five previously

TABLE 1. Sea turtle flipper tag numbers, straight length and width, growth rates, and dates of platform and Imitation Satellite Transmitter application and removal.

Sea Turtle ID Number*	Initial Straight Measurements L X W (cm)	Final Straight Measurements L X W (cm)	Straight Length Growth Rate (cm/yr)	Weight Initial (kg)	Weight Final (kg)	Growth Rate (kg/yr)	Platform Base Applied	IST Applied	IST Removed	Fiberglass Loose on IST Edges**
QQA-025	41.3 x 42.0	49.5 x 50.0	6.2	10.4	15.0	3.5	3/12/91	3/12/91	7/08/92	F - B
QQA-860	40.3 x 41.7	48.5 x 50.3	6.2	10.0	20.0	7.6	3/13/91	4/01/91	7/08/92	R - F - B
QQA-969	42.7 x 40.8	47.2 x 48.0	3.4	10.9	17.3	4.9	3/28/91	4/01/91	7/08/92	R - F - B
QQA-974	38.6 x 37.9	47.0 x 45.0	6.4	8.2	15.4	5.5	3/28/91	4/01/91	7/08/92	R - F - B
QQA-942	39.6 x 39.8	48.0 x 48.0	6.4	9.5	17.7	6.3	3/28/91	4/02/91	7/08/92	F
QQA-106	41.7 x 42.2	47.4 x 47.4	4.3	10.4	18.6	6.3	3/28/91	4/02/91	7/08/92	F
QQA-913	40.1 x 40.4	48.1 x 49.5	6.1	9.5	14.1	3.5	3/28/91	4/02/91	7/08/92	F
QQA-854	38.9 x 39.3	49.8 x 50.9	8.3	9.8	14.1	3.8	3/28/91	4/02/91	7/08/92	F
QQA-121	39.1 x 40.0	47.1 x 48.3	6.1	9.5	13.6	3.1	4/01/91	4/03/91	7/08/92	F
QQA-033	41.4 x 42.0	45.7 x 45.0	3.3	11.4	14.5	2.4	4/01/91	4/03/91	7/08/92	R - F - L - B
QQA-960	42.3 x 43.7	50.5 x 50.9	6.2	11.4	21.3	7.5	4/01/91	4/03/91	7/08/92	F
QQA-063	39.9 x 39.6	50.8 x 48.8	8.3	10.0	20.4	7.9	4/02/91	4/03/91	7/08/92	F

* Hasco Type, Style 681 inconel tags applied to the right flipper of the turtle.

** R = right, F = front, L = left and B = back

tagged wild subadult Kemp's ridley sea turtles.

Wooden molds were constructed to conform to the above dimensions. Prior to pouring the epoxy resin, molds were coated with PAM non-stick cooking spray to facilitate removal of the finished product. Weight was adjusted with split shot fishing lead to achieve a density equal to that of the ST-3 transmitter. Short plastic cable ties were used to simulate a satellite transmitter antenna. Once hardened, each IST was removed from the mold, sanded to remove rough edges, and weighed and measured to verify that the appropriate specifications were achieved.

IST Attachment.—Given the characteristic dorsal ridge of the juvenile Kemp's ridley sea turtle, IST attachment was performed in three phases. Phase one consisted of shell preparation—cleaning, sanding and drying. Phase two involved construction of a level platform on the sea turtle's back for the IST. Finally, the IST was attached with epoxy resin and fiberglass cloth.

A rectangular clay mold was formed on the sea turtle carapace surrounding the area of IST attachment. A two-part epoxy mixture of HobyPox Quick-Fix Formula 4¹ was poured into the mold. Due to the exothermic reaction of the epoxy mixture, the platform was made in multiple layers to prevent excessive heat and discomfort to the sea turtle. Three to five layers were used depending on the height (10–15 mm) of a sea turtle's dorsal ridge. Platforms were 5 cm wide and 11 cm in length. Each layer required approximately 5 minutes to harden. The ISTs were attached by techniques previously used by NMFS for satellite tagging of wild sea turtles. Strips of fiberglass cloth were laid across each IST and allowed to overlap onto the sea turtle carapace. The fiberglass cloth was held in place with epoxy resin. Three separate applications of epoxy and fiberglass cloth were used on each sea turtle. Usually 45–60 minutes of drying was allowed before applying the next layer of epoxy and cloth.

Behavioral Monitoring and IST Maintenance.—Observation of swimming and feeding behavior and documentation of IST sloughing were conducted approximately every two weeks. Conditions considered to be associated with IST sloughing were peeled, chipped, or raised fiberglass cloth. Algal growth on the carapaces of the sea turtles was periodically cleaned off with a medium bristle brush and sponge. This prevented bacterial decomposition of sea turtle food caught in the algae. Removing the algae also facilitated successful assessment of any developments in the sloughing process.

Tag Removal.—The fiberglass cloth was cut with a hacksaw on the front and right sides of the IST. The IST and the remaining fiberglass cloth on the left and rear sides of the carapace were pulled off by hand in one piece. The fiberglass cloth on the anterior and right side of the carapace was easily pried off with a screwdriver.

RESULTS

No ISTs detached during this 16-month study. The epoxy and fiberglass cloth at the margins of all IST attachment points were peeling away from each sea turtle carapace at the termination of this experiment. However 5–7 cm of epoxy and fiberglass cloth remained securely attached to each carapace. Scutes under the IST and fiberglass attachment site were examined after the removal of ISTs. They were comparable to surrounding scutes except for a lighter coloration, likely due to lack of ultraviolet radiation.

Upon completion of the experiment, sea turtles were certified to be in excellent health by a veterinarian. Growth ranged from 2.5 to 8.2 kg/yr (mean = 5.3 kg/yr) and from 3.4 to 8.6 cm/yr (mean = 6.0 cm/yr) in straight length (Table 1). This is similar to other records of Kemp's ridley growth in captivity (Caillouet et al. 1986; Louis et al. 1988).

Our experience with satellite tracking suggests that the transmitting package attached to a turtle's carapace usually outlasts the battery life of the PTT. This is based on erroneous data output by PTTs for approximately one week prior to the cessation of data transmission. Therefore, the period of data transmission by a PTT is generally an underestimate of PTT attachment life. The average life of our PTTs on five loggerhead (*Caretta caretta*) and five Kemp's ridley turtles tracked in the Gulf of Mexico or Atlantic Ocean has been 8.5 and 6.5 months respectively. In two cases, however, PTTs have stopped transmitting within four months without the characteristic week of erroneous data output. Although hard evidence is not available, we suspect that these tags fell off of the turtles. Overall, we feel that PTT detachment is controlled by environmental influences. Sea turtles in our experiment were isolated from each other, held indoors, and thus were not afforded normal environmental contacts such as direct exposure to sun, wave action, weather disturbances, rock jetties, etc. Therefore, we believe that the ISTs would have remained on the sea turtles for several more months.

Evidence suggests that transmitters fiberglassed to the carapace of wild sea turtles sustain impacts during daily activities. One green sea turtle (*Chelonia mydas*) tagged during a radio-tracking experiment at South Padre Island, Texas (Renaud et al. 1992), was recaptured 8 months later without its radio transmitter or sonic tag. In a second study (Renaud et al. 1993) antennas on tags broke off or tags were detached from 5 of 9 green turtles tracked in the vicinity of rock jetties over a 60 day period. Visual observation of these turtles disclosed that every transmitter antenna was bent during the first week of the study. All transmitters were attached in the same manner described in this report.

Sea turtle behaviors (which include swimming through seagrass beds, burrowing in the mud, and wedging under rock overhangs or between rocks) create a harsher environment than that encountered under laboratory conditions. It is not surprising that tags became detached in less time than under laboratory conditions or conversely, that tags in the laboratory did not detach from the sea turtles. We believe that the inshore environment is harsher than the offshore environment and that tags will not last as long on sea turtles inhabiting regions near rock groins or seagrass beds.

It is now hypothesized that PTTs will come off in one piece, preventing a partially detached PTT from being carried by a sea turtle. This is supported by an earlier tagging experience in 1990 (NMFS unpublished data) when a satellite transmitter with its hardened fiberglass attachment was accidentally knocked off a sea turtle in one piece. This hypothesis is further substantiated by the easy removal of ISTs and fiberglass cloth at the conclusion of this experiment. There was no attempt to remove the ISTs by pulling off the entire package in one piece. In hindsight, though, we should have tried this because the ISTs came off very easily once cut on two sides. A few bumps or jolts on rocks or other solid objects in the environment may produce the same result.

If tags fall off juvenile sea turtles within 12 months, they would not interfere with breeding behavior. Small PTT's would probably not interfere with mating turtles, or in the worst case, be knocked off a female turtle during the mating process.

We do not think that PTTs make sea turtles more vulnerable to predation. Tags blend in with the color of the sea turtle carapace and are quickly overgrown with algae to reduce any visual cues of their presence. White barnacles are commonly seen on sea turtle shells in the wild. The high contrast of the barnacle shell would offer more of a visual cue to a predator than a larger PTT with less contrast.

This experiment tested the longevity of packages fiberglassed to sea turtle carapaces. The design of satellite transmitters takes into account swimming and related behaviors (R. A. Byles, pers. comm.). Tags are small compared to sea turtles (<6% body weight) and are relatively streamlined to produce minimal resistance to swimming. The swimming and feeding behaviors of the experimental sea

turtles appeared comparable to those of hundreds of captive-raised and wild sea turtles previously observed by the authors in captivity. ISTs did not seem to interfere with daily turtle activity. Sea turtles moved swiftly through the water in their holding tanks and executed quick, sharp turns necessary for the capture of live prey items in the wild. These turtles captured and fed on live crabs while in captivity. Their increase in weight and length during the experiment falls within the growth range of similar-aged turtles (Louis et al. 1988).

In a study similar to ours, Beavers et al. (1991) compared longevity of tag attachment and ease of tagging among 1) polyester resin with fiberglass cast base, 2) epoxy alone, and 3) dental compound with fiberglass cast base. Their choice of tag attachment was dental compound due to quick setting time. No shedding time was given. Tags attached with polyester resin or epoxy remained on the turtles for at least 142 days. No deleterious effects on the sea turtles or changes in sea turtle behavior due to tag attachment were noted by Beavers et al. (1991).

Based on our results, we feel that transmitter packages attached to the carapace of sea turtles are not harmful. Continuous data on sea turtles in the wild is lacking and the use of satellite telemetry is a cost-effective means of collecting such information. If the tags can last for 6–10 months they can provide a wealth of data on sea turtle behavior.

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MAURICE L. RENAUD
GREGG R. GITSCHLAG
and
JON K. HALE
National Marine Fisheries Service
Southeast Fisheries Center
Galveston Laboratory
4700 Avenue U
Galveston, Texas 77551, USA.

¹ When this experiment was conducted, HobyPox was the preferred substance for platform construction. Due to variability in the exothermic reaction of this substance it is no longer recommended for use. Now we construct platforms in advance with dental compound, a non-toxic, cold-cure medium. Each platform can be cut with a razor blade to fit the dorsal ridge of any sea turtle just prior to tag attachment. A considerable reduction in the out-of-water time for each sea turtle is achieved by having these platforms made in advance.

Adhesive Trapping II

Bauer and Sadlier (1992) introduced the herpetological community to sampling possibilities offered by mouse glue traps (Woodstream, Inc., P.O. Box 327, Lititz, Pennsylvania 17543, USA) and extolled the virtues of adhesive trapping for sampling arboreal lizards. Since 1988, we have used adhesive trapping to sample a variety of reptiles and amphibians on islands of the western Pacific under a wide range of conditions. Our cumulative sampling experience exceeds 30,000 trap-h (one trap set for one hour = 1 trap-h). Adhesive traps are often the best available sampling method.

While adhesive traps offer a high capture rate, relative ease of use, and some utility for wary species, they do have some disadvantages. Capture rate declines sharply with time in place (Fig. 1); this reduction is probably due to both localized depletion of trap-vulnerable animals and deterioration of the adhesive. Dust, water, debris, and insects will cover the sticky surface of a trap and render it ineffective. Rain almost completely disables a trap, and moisture weakens the backing paper. Glueboards by other manufacturers can be backed with shallow plastic trays, but rain water accumulates in the plastic trays and renders them useless. When we have set plastic and paper-backed traps in alternation ($N > 700$ trap-h), the plastic-backed traps captured 95% fewer reptiles than the paper traps. Because of rapid decline in trap effectiveness, paper backed traps are rarely useful for more than one 24-h period; their modest cost (\$.50/trap when purchased in bulk) justifies replacing them frequently. In countries without a trash removal system, we have found it difficult to dispose of used adhesive traps without the spent traps coming in contact with children or domestic animals. Under these conditions they should probably be buried or burned.

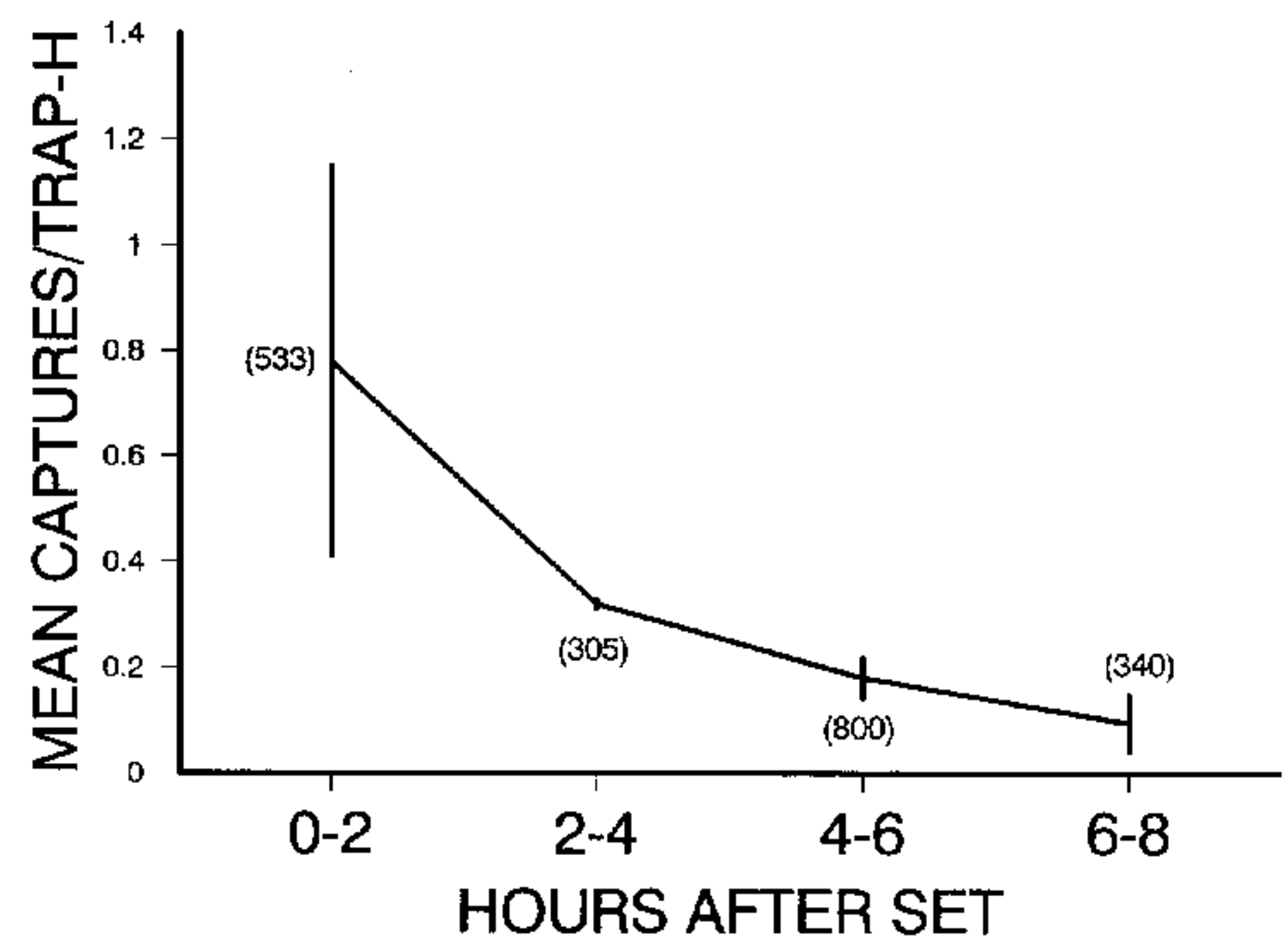


FIG. 1. Decline in success of capture of lizards on adhesive traps following setting, based on daylight captures from single-day ground-trap arrays on Guam (symbols represent catches at respective sets). Error bars are standard deviations of the means for each array (arrays consisted of 8–36 traps). The decline in capture success from 0–2 to 2–4 h after set is not attributable to the normal activity cycle of lizards in this area, which typically reach maximal levels at 1000–1200 h, 2–4 h after initiation of trapping. When trapping was continued for additional days, subsequent mean capture rates did not exceed 25% of the rate achieved during the first two hours.

Glue viscosity is affected by temperature and below 20°C it is challenging to remove delicate lizards without tail loss; an extremely slow, gentle pull is required. Bauer and Sadlier (1992) noted that corn oil dissolves the adhesive and facilitates removal. Robust skinks can usually be removed in excellent condition and without resorting to oil. Geckos, especially those with delicate skins (Bauer et al. 1989), must be oiled for removal. If an unoiled reptile is discovered to have some residual stickiness after removal, it should